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National Eutrophication Survey, Corvallis, Oreg

Prepared for

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Report
on
Lake Lewisville (Garza-Little Elm)
Denton County
Texas
EPA Region VI
Working Paper No. 650

With the cooperation of the
Texas Water Quality Board
and the
Texas National Guard
March, 1977

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16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGEMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Texas Water Quality Board for professional involvement, to the Texas National Guard for conducting the tributary sampling phase of the Survey, and to those Texas wastewater treatment plant operators who voluntarily provided effluent samples.

Hugh C. Yantis, Jr., Executive Director of the Texas Water Quality Board, and John B. Latchford, Jr., Director, and the staff of the Field Operations Division provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

Major General Thomas Bishop, the Adjutant General of Texas, and Project Officer Colonel William L. Seals, who directed the volunteer efforts of the Texas National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY RESERVOIRS

State of Texas

NAME	COUNTY
Amistad	Val Verde
Bastrop	Bastrop
Belton	Bell, Coryell
Braunig	Bexar
Brownwood	Brown
Buchanan	Burnet, Llano
Caddo	Harrison, Marion, TX; Caddo Parish, LA
Calaveras	Bexar
Canyon	Comal
Colorado City	Mitchell
Corpus Christi	Jim Wells, Live Oak, San Patricio
Diversion	Archer, Baylor
Eagle Mountain	Tarrant, Wise
Fort Phantom Hill	Jones
Houston	Harris
Kemp	Baylor
Lake O'The Pines	Camp, Marion, Morris, Upshur
Lavon	Collin
Lewisville (Garza-Little Elm)	Denton
Livingston	Polk, San Jacinto, Trinity, Walker

Lyndon B. Johnson	Burnet, Llano
Medina	Bandera, Medina
Meredith	Hutchinson, Moore, Potter
O. C. Fisher (San Angelo)	Tom Green
Palestine	Anderson, Cherokee, Henderson, Smith
Possum Kingdom	Palo Pinto, Stephens, Young
Sam Rayburn	Angelina, Jasper Nacogdoches, Sabine, San Augustine
Somerville	Burleson, Lee, Washington
E. V. Spence	Coke
Stamford	Haskell
Stillhouse Hollow	Bell
Tawakoni	Hunt, Rains, Van Zandt
Texoma	Cooke, Grayson TX; Bryan, Johnston, Love, Marshall, OK
Travis	Burnet, Travis
Trinidad	Henderson
Twin Buttes	Tom Green
White River	Crosby
Whitney	Bosque, Hill
Wright Patman (Texarkana)	Bowie, Cass

LAKE LEWISVILLE

LAKE LEWISVILLE

STORET NO. 4815

I. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that Lake Lewisville is eutrophic; i.e., well supplied with nutrients and quite productive. Whether nutrient enrichment is beneficial or deleterious depends on the actual or potential effect on the uses of the lake. In this regard, no nuisance conditions are known to personnel of the Texas Water Quality Board and there is little or no impairment of the designated beneficial uses of this water body.

Lake Lewisville ranked 34th in overall trophic quality when the 39 Texas reservoirs sampled in 1974 were compared using a combination of six parameters*. Twenty-five of the reservoirs had less median total phosphorus, 29 had less and two had the same median dissolved phosphorus, 33 had less median inorganic nitrogen, 25 had less mean chlorophyll a, and 32 had greater mean Secchi disc transparency. Marked depression of dissolved oxygen with depth occurred at station 1 in August (0.4 mg/l at 13.7 meters).

Survey limnologists did not observe any phytoplankton blooms or widespread macrophytes.

Excess available phosphorus levels in the Elm Fork embayment suggest potential problems (Anonymous, 1974(7)).

* See Appendix A.

B. Rate-Limiting Nutrient:

The algal assay results indicate that primary productivity was limited by phosphorus at the time of sampling (03/11/74).

The lake data indicate phosphorus was limiting in March and May, and nitrogen was limiting in October. However, the mean Secchi disc transparency of less than one meter indicates primary productivity may be light-limited at times.

C. Nutrient Controllability:

1. Point sources--During the sampling year, a little over 29% of the total phosphorus load is estimated to have been contributed by point sources. The City of Denton wastewater treatment plant was the largest source with 24.2% of the total.

The present loading of 1.25 $g/m^2/yr$ is almost 2.5 times that proposed by Vollenweider (Vollenweider and Dillon, 1974) as a eutrophic loading (see page 17). Although elimination of all point-source phosphorus loads would only reduce the loading to 0.88 $g/m^2/yr$, if Vollenweider's eutrophic level is applicable to Texas reservoirs, phosphorus control could reduce the potential for the occurrence of nuisance conditions since it appears that suspended materials (as measured by the Secchi disc) might also be limiting primary productivity.

2. Non-point sources--the gaged tributaries were estimated to have contributed about 55% of the total phosphorus load reaching Lake Lewisville. The Elm Fork Trinity River contributed 29.7%; the Isle Du Bois Creek, 13.6%; and the other two tributaries collectively contributed 12.0%.

The phosphorus export rates (page 16) ranged from 7 to 45 kg $P/km^2/yr$ with the Elm Fork Trinity River and Little Elm Creek having the highest values (35 and 45 kg $P/km^2/yr$, respectively). Both tributaries may have been influenced by point sources within and outside the 40-kilometer limit of the Survey*.

* See Working Paper No. 175, "...Survey Methods, 1973-1976".

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS[†]

A. Morphometry[††]:

1. Surface area: 93.93 kilometers^2.
2. Mean depth: 6.0 meters.
3. Maximum depth: 20.4 meters.
4. Volume: 564.464 x 10^6 m^3.
5. Mean hydraulic retention time: 0.85 years (based on 1972-1976 mean outflow).

B. Tributary and Outlet:
(See Appendix C for flow data)

1. Tributaries -

Name	Drainage area (km^2)*	Mean flow (m^3/sec)*
Elm Fork Trinity River	966.8	4.080
Clear Creek	764.0	2.100
Isle Du Bois Creek	688.9	3.520
Little Elm Creek	195.5	1.177
Minor tributaries & immediate drainage -	1,570.0	6.630
Totals	4,205.2	17.507

2. Outlets -

Diversion by City of Denton**	-	0.200
Elm Fork Trinity River	4,299.4	17.307
Totals	4,299.4***	17.507***

C. Precipitation****:

1. Year of sampling: 110.2 centimeters.
2. Mean annual: 84.6 centimeters.

† Table of metric conversions--Appendix B.
†† At conservation pool level; Barrows, 1977.
* For limits of accuracy, see Working Paper No. 175.
** Jones, 1976 (see page 12).
*** Includes area of lake; outflow adjusted to equal sum of inflows.
**** See Working Paper No. 175.

III. WATER QUALITY SUMMARY

Lake Lewisville was sampled four times in 1974 by means of a pontoon-equipped Huey helicopter. Samples for physical and chemical parameters were collected from two or more depths at six stations on the lake (five in March; see map, page vi). During each visit, a single depth-integrated (4.6 m or near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the first visit, two 18.9-liter depth-integrated samples were composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll *a* analysis. The maximum depths sampled were 16.2 meters at station 1, 9.1 meters at station 2, 10.1 meters at station 3, 8.8 meters at station 4, 7.6 meters at station 5, and 2.1 meters at station 6.

The sampling results are presented in full in Appendix D and are summarized in the following table.

A SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR LAKE LITTLE SILVER
STUDY CODE 4825

PARAMETER	1ST SAMPLING : 7/11/74 5 SITES RANGE	MEAN	MEDIAN	2ND SAMPLING : 8/13/74 6 SITES RANGE	MEAN	MEDIAN	3RD SAMPLING : 9/12/74 6 SITES RANGE	MEAN	MEDIAN
TEMP (C)	14.2 - 18.0	16.4	16.5	20.1 - 21.0	21.0	20.5	15.0 - 17.0	16.1	16.2
DISS OXY (MG/L)	7.4 - 10.9	9.0	9.0	5.6 - 7.6	6.9	7.0	8.4 - 8.5	8.2	8.2
CNDCTVY (MICROMH)	254. - 322.	291.	295.	336. - 478.	394.	384.	334. - 375.	357.	356.
PH (STAND UNITS)	7.0 - 8.2	8.1	8.1	7.6 - 8.4	8.2	8.2	7.7 - 8.7	8.4	8.4
TOT ALK (MG/L)	107. - 126.	113.	113.	107. - 119.	113.	113.	116. - 134.	125.	126.
TOT P (MG/L)	0.028 - 0.044	0.034	0.042	0.019 - 0.034	0.026	0.028	0.021 - 0.029	0.024	0.028
DISS P (MG/L)	0.007 - 0.015	0.011	0.009	0.004 - 0.011	0.007	0.009	0.004 - 0.007	0.004	0.004
NITRATE (MG/L)	0.156 - 0.346	0.264	0.288	0.350 - 0.486	0.437	0.447	0.365 - 0.398	0.379	0.379
AMMONIA (MG/L)	0.056 - 0.140	0.077	0.070	0.045 - 0.070	0.054	0.045	0.040 - 0.110	0.073	0.070
KJEL N (MG/L)	0.280 - 0.588	0.386	0.350	0.380 - 1.100	0.670	0.480	0.280 - 0.490	0.417	0.420
INORG N (MG/L)	0.234 - 0.476	0.334	0.308	0.316 - 0.516	0.396	0.438	0.284 - 0.394	0.337	0.340
TOTAL N (MG/L)	0.384 - 0.752	0.474	0.658	0.730 - 1.446	1.066	1.046	0.470 - 0.860	0.671	0.760
CHLOPHYL A (UG/L)	1.2 - 4.1	2.5	2.4	19.3 - 32.4	25.5	25.8	4.4 - 25.4	14.3	13.7
SECCHI (METERS)	6.5 - 8.4	8.4	8.4	3.1 - 3.4	3.3	3.3	5.1 - 5.4	5.3	5.3

A SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR SAND LITTLE [illegible]
STREET CODE 4405

[illegible] SAMPLING (10/31/74)

	4 SITES		
PARAMETER	RANGE	MEAN	MEDIAN
TEMP (C)	16.1 - 16.7	16.3	15.4
DISS OXY (MG/L)	6.2 - 8.2	7.5	7.6
CONDUCTVY (MICROMHO)	177. - 187.	243.	187.
PH (STAND UNITS)	7.1 - 7.8	7.4	7.4
TOT ALK (MG/L)	98. - 134.	94.	88.
TOT P (MG/L)	0.027 - 1.252	0.251	0.041
ORTHO P (MG/L)	0.009 - 0.068	0.041	0.034
NO2+NO3 (MG/L)	0.158 - 0.429	0.294	0.246
AMMONIA (MG/L)	0.033 - 0.178	0.071	0.058
KJEL N (MG/L)	0.780 - 2.488	0.894	0.580
INORG N (MG/L)	0.192 - 0.769	0.347	0.388
TOTAL N (MG/L)	0.958 - 3.073	0.955	0.946
CHLOPYL A (UG/L)	5.3 - 25.7	12.1	10.0
SECCHI (METERS)	0.1 - 0.7	0.4	0.3

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
03/11/74	1. Chroomonas sp.	87
	2. Stephanodiscus sp.	65
	3. Cryptomonas sp.	43
	Total	195
05/17-20/74	1. Chroomonas sp.	308
	2. Cryptomonas sp.	154
	3. Ceratium sp.	51
	4. Euglena sp.	51
	5. Melosmopedia sp.	51
	Other genera	206
	Total	821
08/12/74	1. Raphidiopsis sp.	1,627
	2. Synedra sp.	757
	3. Centric diatoms	668
	4. Lyngbya sp.	630
	5. Oscillatoria sp.	530
	Other genera	605
	Total	4,617
10/31/74	1. Cryptomonas sp.	30
	2. Scenedesmus sp.	30
	3. Chrysophytan cells	30
	Total	90

B. Chlorophyll A -

Sampling Date	Station Number	Chlorophyll A (ug/l)
03/11/74	1	1.2
	2	2.1
	3	4.0
	4	3.0
	5	2.4
	6	-
05/17-20/74	1	19.4
	2	29.3
	3	31.7
	4	32.9
	5	20.7
	6	19.3
08/12/74	1	4.4
	2	12.0
	3	12.0
	4	15.4
	5	16.4
	6	25.8
10/31/74	1	5.3
	2	12.5
	3	8.1
	4	11.5
	5	12.5
	6	23.7

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

a. Stations 1, 2, and 3 -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	<0.005	0.345	0.2
0.050 P	<0.055	0.345	7.6
0.050 P + 1.0 N	<0.055	1.345	12.4
1.0 N	<0.005	1.345	0.1

b. Stations 4 and 5 -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	<0.005	0.405	0.1
0.050 P	<0.055	0.405	8.0
0.050 P + 1.0 N	<0.055	1.405	17.8
1.0 N	<0.005	1.405	0.1

8. Discussion -

The control yields of the assay alga, Selenastrum capricornutum, indicate that the potential primary productivity of Lake Lewisville was low at the time the assay samples were collected (03/11/74). In both assays, the increased yields resulting from increased concentrations of orthophosphorus indicate that the lake was limited by phosphorus at that time. Note that the addition of only nitrogen did not result in increased yields.

The lake data indicate phosphorus limitation in March and May (the mean inorganic nitrogen/orthophosphorus ratios were 14/1 or greater at all stations, with the exception of station 6 in May). The August and November lake data indicate a combination of limiting nutrients. Following is a tabulation of the mean inorganic nitrogen/orthophosphorus ratios for each of the sampling stations and times with indicated limiting nutrient in parentheses:

Station	03/11/74	05/17/74	08/12/74	10/31/74
1	18/1 (P)	27/1 (P)	23/1 (P)	9/1 (N)
2	26/1 (P)	83/1 (P)	9/1 (N)	14/1 (P)
3	23/1 (P)	49/1 (P)	23/1 (P)	11/1 (N)
4	14/1 (P)	10/1 (P)	11/1 (N)	9/1 (N)
5	24/1 (P)	47/1 (P)	10/1 (P)	6/1 (N)
6	-	10/1 (N)	33/1 (P)	5/1 (N)

IV. NUTRIENT LOADINGS
(See Appendix E for data)

For the determination of nutrient loadings, the Texas National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page vi), except for the months of April and May when two samples were collected. Sampling was begun in September, 1974, and was completed in August, 1975.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Texas District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were calculated using mean concentrations and mean flows. Nutrient loads shown are those measured minus point-source loads, if any.

Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the mean concentrations in Clear Creek at station C-1 and the mean ZZ flow.

The City of Denton reported a mean diversion of 0.20 m^3/sec from Lake Lewisville during the year (Jones, 1976). Nutrient loads in the diverted water were estimated using the mean lake nutrient concentrations at station three and the mean diversion flow.

The operators of the Celina, Frisco, Gunter, and Krum wastewater treatment plants provided monthly effluent samples and corresponding flow data. The communities of Denton, Lake Dallas, Lakewood Village,

and Prosper did not participate, and nutrient loads were estimated at 1.131 kg P and 3.101 kg N/capita/year.

A. Waste Sources:

1. Known municipal -

Name	Pop. Served	Treatment	Mean Flow (m^3/d)	Receiving Water
Celina*	1,272	stab. pond	455.4	Little Elm Creek
Denton**	28,000	act. sludge	14,195.3	Pecan Creek
Frisco				
Cottonwood*	2,200	act. sludge	1,002.0	Cottonwood Creek
Stewart*	800	stab. pond	568.1	Steward Creek
Gunter*	640	stab. pond	147.1	Little Elm Creek
Krum*	700	stab. pond	98.8	Hickory Creek
Lake Dallas M.U.D.**	1,350	cont. aer.	757.1	Lake Lewisville
Lakewood Village Util. Co.**	80	ext. aer.	45.4	Lake Lewisville
Prosper***	200	stab. pond	37.8	Ditch to Doe Branch

2. Known industrial - None

* Treatment plant questionnaires.
** Wyatt, 1976.
*** Anonymous, 1974(?).

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/yr	% of total
a. Tributaries (non-point load) -		
Elm Fork Trinity River	34,740	29.7
Clear Creek	5,300	4.5
Isle Du Bois Creek	15,875	13.6
Little Elm Creek	8,755	7.5
b. Minor tributaries & immediate drainage (non-point load) -	16,725	14.3
c. Known municipal STP's -		
Celina	1,215	1.0
Denton	28,350	24.2
Frisco		
Cottonwood	1,595	1.4
Stewart	645	0.6
Gunter	275	0.2
Krum	135	0.1
Lake Dallas M.U.D.	1,530	1.3
Lakewood Village Util. Co.	90	<0.1
Prosper	225	0.2
d. Septic tanks - Unknown	?	-
e. Known industrial - None	-	-
f. Direct precipitation* -	1,650	1.4
Total	117,105	100.0

2. Outputs -

Lake outlets - City of Denton diversion	1,505	
Elm Fork Trinity River	35,475	
Total	36,980	

3. Net annual P accumulation - 80,125 kg.

* See Working Paper No. 175.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/yr	% of total
a. Tributaries (non-point load) -		
Elm Fork Trinity River	286,410	27.4
Clear Creek	62,320	6.0
Pole Du Bois Creek	153,855	14.7
Little Elm Creek	70,425	6.7
b. Minor tributaries & immediate drainage (non-point load) -	196,750	18.8
c. Known municipal STP's -		
Celina	2,770	0.3
Denton	85,025	8.1
Frisco		
Cottonwood	4,185	0.4
Stewart	76,860	7.3
Gunter	595	0.1
Krum	285	<0.1
Lake Dallas M.U.D.	4,590	0.4
Lakewood Village Util. Co.	270	<0.1
Prosper	680	0.1
d. Septic tanks - Unknown	?	-
e. Known industrial - None	-	-
f. Direct precipitation* -	101,710	9.7
Total	1,046,730	100.0

2. Outputs -

Lake outlets -	City of Denton diversion	6,530
	Elm Fork Trinity River	522,870
	Total	529,400

3. Net annual N accumulation - 517,330 kg.

* See Working Paper No. 175.

D. Non-point Nutrient Export by Subdrainage Area:

Tributary	kg P/km²/yr	kg N/km²/yr
Elm Fork Trinity River	35	290
Clear Creek	7	82
Isle Du Bois Creek	93	223
Little Elm Creek	46	360

E. Mean Nutrient Concentrations in Ungaged Streams:

Tributary	Mean Total P Conc. (mg/l)	Mean Total N Conc. (mg/l)
Buck Creek (K-1)	0.239	1.952
Buck Creek (L-1)	0.207	1.735
Hickory Creek	0.145	1.689
Hog Creek	0.108	1.584
Range Creek (G-1)	0.208	1.640
Range Creek (J-1)	0.209	1.704

F. Yearly Loads:

In the following table, the existing phosphorus loadings are compared to those proposed by Vollenweider (Vollenweider and Dillon, 1974). Essentially, his "dangerous" loading is one at which the receiving water would become eutrophic or remain eutrophic; his "permissible" loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic loading would be considered one between "dangerous" and "permissible".

Note that Vollenweider's model may not be applicable to water bodies with short hydraulic retention times.

	Total Phosphorus		Total Nitrogen	
	Total	Accumulated	Total	Accumulated
grams/m^2/yr	1.25	0.85	11.1	5.5

Vollenweider phosphorus loadings ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Lake Lewisville:

"Dangerous" (eutrophic loading)	0.52
"Permissible" (oligotrophic loading)	0.26

V. LITERATURE REVIEWED

Anonymous, 1974(?). Intensive surface water monitoring survey for segment 0823 (Lake Lewisville). Rept. No. IMS 5, TX Water Qual. Bd., Austin.

Barrows, David, 1977. Personal communication (morphometry and hydraulic retention time). Canyon Proj. Off., Fort Worth Distr., Corps of Engrs., New Braunfels, TX.

Hendricks, Albert C., and J. K. G. Silvey, 1973. Nutrient ratio variation in reservoir sediments. Jour. Water Poll. Contr. Fed., vol. 45, no. 3, pp. 490-497.

Jones, Earl, 1976. Personal communication (municipal withdrawal from Lake Lewisville). Denton.

Vollenweider, R. A., and P. J. Dillon, 1974. The application of the phosphorus loading concept to eutrophication research. Natl. Res. Council of Canada Publ. No. 13690, Canada Centre for Inland Waters, Burlington, Ontario.

Wyatt, Linda B., 1976. Personal communication (sewage treatment plant information). TX Water Qual. Bd., Austin.

VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE CODE	LAKE NAME	[illegible] TOTAL P	[illegible] [illegible] %	[illegible] [illegible] SQ	[illegible] CHLOR	[illegible] [illegible]	[illegible] [illegible] [illegible]
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] [illegible]

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	[illegible] TOTAL P	[illegible] INDEX P	SUB- [illegible] SEC	[illegible] DEPTH	[illegible] MIN. DO	[illegible] INDEX (mg/L) P
[illegible]	SOMERVILLE LAKE	0.553	0.115	473,633	24.491	13.500	0.811
[illegible]	STAMFORD LAKE	0.873	0.198	482,734	18.457	18.481	0.312
[illegible]	STILLHOUSE TULLOS RESERV	0.851	0.195	484,258	3.917	15.881	0.818
[illegible]	TAWAKONI LAKE	0.84[illegible]	0.188	465,417	16.246	13.200	0.813
[illegible]	TEXOMA LAKE	0.83[illegible]	0.178	476,508	19.219	12.408	0.836
[illegible]	TOLEDO BEND LAKE	0.82[illegible]	0.198	451,321	12.491	15.381	0.818
[illegible]	TRAVIS LAKE	0.81[illegible]	0.258	395,913	5.595	15.881	0.807
[illegible]	WHITNEY	0.80[illegible]	0.118	478,588	24.381	18.888	0.248
[illegible]	WICHITA FALLS RESERVOIR	0.80[illegible]	0.258	454,917	8.788	14.881	0.889
[illegible]	WRIGHT PATMAN RESERVOIR	0.80[illegible]	0.118	434,588	4.333	15.486	0.884
[illegible]	WYCHE LAKE	0.80[illegible]	0.128	438,588	5.912	15.888	0.88[illegible]

LAKE CODE	LAKE NAME	[illegible] TOTAL P	[illegible] [illegible] %	[illegible] [illegible] SEC	[illegible] CHLORA	[illegible] [illegible]	[illegible] [illegible] [illegible] P	[illegible] [illegible]
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] RESERVOIR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAKE [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] RESERVOIR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] LAKE [illegible] CITY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] [illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	EAGLE [illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	FT PHANTOM [illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] LITTLE ELK [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAKE OF THE PINES	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] RESERVOIR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] B JOHNSON LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAKE [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	PALESTINE LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] [illegible] RESERVOIR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SAN ANGELO RESERVOIR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SAN [illegible] RESERVOIR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	E V SPENCE RESERVOIR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	[illegible]	[illegible] RESERVOIR	[illegible]
2	[illegible]	LAKE [illegible]	[illegible]
3	[illegible]	EAGLE MOUNTAIN LAKE	[illegible]
4	[illegible]	[illegible] LAKE	[illegible]
5	[illegible]	[illegible] LAKE	[illegible]
6	[illegible]	[illegible] LAKE	[illegible]
7	[illegible]	[illegible] LAKE	[illegible]
8	[illegible]	[illegible] [illegible] RESERVOIR	[illegible]
9	[illegible]	[illegible] [illegible] RESERVOIR	[illegible]
10	[illegible]	TRAVIS LAKE	[illegible]
11	[illegible]	BELTON RESERVOIR	[illegible]
12	[illegible]	STILLHOUSE HOLLOW RESERV	[illegible]
13	[illegible]	[illegible] LAKE	[illegible]
14	[illegible]	DULANEY LAKE	[illegible]
15	[illegible]	[illegible] LAKE	[illegible]
16	[illegible]	[illegible] LAKE	[illegible]
17	[illegible]	[illegible] [illegible] RESERVOIR	[illegible]
18	[illegible]	E. V. SPENCE RESERVOIR	[illegible]
19	[illegible]	TWIN BUTTES RESERVOIR	[illegible]
20	[illegible]	LAKE CALHOUN CITY	[illegible]
21	[illegible]	PALESTINE LAKE	[illegible]
22	[illegible]	LAKE OF THE PINES	[illegible]
23	[illegible]	CADDO LAKE	[illegible]
24	[illegible]	FT PHANTOM HILL LAKE	[illegible]
25	[illegible]	LAKE [illegible]	[illegible]
26	[illegible]	STAMFORD LAKE	[illegible]
27	[illegible]	LAVON RESERVOIR	[illegible]
28	[illegible]	TAWAKONI LAKE	[illegible]

LAKES RANKED BY INDEX NO.

RANK	LAKE CODE	LAKE NAME	INDEX NO.
29	[illegible]	LYNDON B JOHNSON LAKE	239
30	[illegible]	TEXOMA LAKE	237
31	[illegible]	SOMERVILLE LAKE	230
32	[illegible]	SAN ANGELO RESERVOIR	230
33	[illegible]	TEXARKANA LAKE	176
34	[illegible]	GARZA LITTLE ELM RESERVOIR	172
35	[illegible]	TRINIDAD	169
36	[illegible]	BRYANS LAKE	159
37	[illegible]	CORPUS CHRISTI LAKE	155
38	[illegible]	HOUSTON LAKE	129
39	[illegible]	LIVINGSTON LAKE	48

APPENDIX B

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 6.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX C

TRIBUTARY FLOW DATA

LAKE CUBE 4915 LEWISVILLE RESERVOIR

TOTAL DRAINAGE AREA OF LAKE(SQ MI) 4795.4

WATERSHED	SUB-DRAINAGE AREA(SQ MI)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
							MONTHLY FLOWS(CMS)							
4915A1	4795.4	34.33	38.93	21.42	19.34	37.41	38.57	14.87	8.69	18.99	16.78	34.38	17.44	17.49
4915A2	986.8	2.35	3.47	3.16	7.56	18.48	3.77	1.56	1.61	4.67	2.75	3.65	2.94	4.59
4915C1	754.3	1.79	1.84	2.13	4.38	5.81	2.61	0.54	0.47	2.44	1.19	2.12	1.34	0.16
4915D1	488.9	1.67	2.75	3.65	8.87	7.45	3.57	1.82	1.48	5.44	1.74	3.17	2.75	2.52
4915F1	185.5	0.491	0.863	1.241	3.858	3.405	0.451	0.136	0.349	1.44	0.545	0.936	0.991	1.177
4915U1	1940.8	3.61	5.69	6.48	13.45	25.49	9.85	2.13	1.13	8.42	3.42	6.46	4.07	6.43

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 4795.4 TOTAL FLOW IN = 219.67
SUM OF SUB-DRAINAGE AREAS = 4795.1 TOTAL FLOW OUT = 219.25

ROUTING OF DAILY FLOWS AND DAILY FLOWS(CMS)

WATERSHED	HOUR	DAY	INFLOW	OUTFLOW	DAY	STORAGE	DAY	EVAPORATION
4915A1	7	74	8,757	0	5,442			
	10	74	18,344	0	18,387			
	11	74	112,419	10	106,184			
	12	74	118,848	15	124,825			
	1	75	12,483	12	7,445			
	2	75	84,181	0	53,519			
	3	75	34,877	14	36,712			
	4	75	43,325	13	8,778	27	14,279	
	5	75	28,253	14	43,455	31	34,877	
	6	75	65,254	24	182,567			
	7	75	7,419	29	3,483			
	8	75	6,233	17	4,781			
4915A2	9	74	31,841	0	6,147			
	10	74	34,347	0	8,953			
	11	74	32,447	10	139,838			
	12	74	1,864	15	2,834			
	1	75	4,533	12	1,614			
	2	75	15,448	0	6,774			
	3	75	24,393	18	94,562			
	4	75	4,841	11	4,434	31	1,414	
	5	75	7,324	19	1,248	31	16,758	
	6	75	4,174	24	3,265			
	7	75	8,421	29	8,344			
	8	75	1,561	17	4,879			

APPENDIX D

PHYSICAL and CHEMICAL DATA

[illegible]

[illegible]
[illegible]
[illegible]

[illegible]
[illegible]

DATE	TIME	DEPTH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FROM	OF		WATER	DO	THERMOP	CONDUCTIV	PH	T ALK	[illegible]	TOT [illegible]	[illegible]	[illegible]
TO	DAY	FEET	DEPTH	[illegible]	JETTED	FIELD		CACO3	TOTAL	[illegible]	[illegible]	[illegible]
			CFS	MG/L	INCHES	MICROMHOS	SU	MG/L	MG/L	MG/L	MG/L	MG/L
04/03/11	11	40	[illegible]	15.2		24	263	8.20	107	[illegible]	[illegible]	[illegible]
	11	40	[illegible]	14.9	9.2		263	8.15	107	[illegible]	[illegible]	[illegible]
	11	40	[illegible]	14.7	9.0		261	8.15	107	[illegible]	[illegible]	[illegible]
	11	40	[illegible]	14.5	8.9		259	8.05	107	[illegible]	[illegible]	[illegible]
	11	40	[illegible]	14.2	8.9		256	8.05	107	[illegible]	[illegible]	[illegible]
04/05/17	16	05	[illegible]	23.9		36	371	8.30	134	[illegible]	[illegible]	[illegible]
	16	05	[illegible]	23.4	7.8		369	8.25	134	[illegible]	[illegible]	[illegible]
	16	05	[illegible]	22.9	8.6		362	8.20	133	[illegible]	[illegible]	[illegible]
	16	05	[illegible]	21.6	7.8		351	8.00	134	[illegible]	[illegible]	[illegible]
	16	05	[illegible]	20.1	5.8		335	7.90	134	[illegible]	[illegible]	[illegible]
04/20/12	11	35	[illegible]	20.2	5.6	72	354	8.10	134	[illegible]	[illegible]	[illegible]
	11	35	[illegible]	20.1	5.1		353	8.11	135	[illegible]	[illegible]	[illegible]
	11	35	[illegible]	20.1	5.0		354	8.06	128	[illegible]	[illegible]	[illegible]
	11	35	[illegible]	25.0	6.4		375	7.86	134	[illegible]	[illegible]	[illegible]
04/30/31	09	25	[illegible]	15.4	7.6	38	315	7.91	134	[illegible]	[illegible]	[illegible]
	09	25	[illegible]	14.4	7.8		315	7.91	137	[illegible]	[illegible]	[illegible]
	09	25	[illegible]	14.4	7.2		315	7.91	137	[illegible]	[illegible]	[illegible]
	09	25	[illegible]	14.4	7.8		315	7.91	134	[illegible]	[illegible]	[illegible]
	09	25	[illegible]	14.4	7.8		313	7.89	137	[illegible]	[illegible]	[illegible]
	09	25	[illegible]	15.4	8.2		313	7.89	139	[illegible]	[illegible]	[illegible]

[illegible]

* VALUE KNOWN TO BE
LESS THAN INDICATED

[illegible]

[illegible]

[illegible]

DATE FROM TO	TIME OF DAY	DEPTH FEET	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	11 48	0000	[illegible]	[illegible]	[illegible]
	11 48	0005	[illegible]		
	11 48	0010	[illegible]		
	11 48	0025	[illegible]		
	11 48	0041	[illegible]		
[illegible]	16 25	0000	[illegible]	[illegible]	
	16 25	0005	[illegible]		
	16 25	0010	[illegible]		
	16 25	0030	[illegible]		
	16 25	0040	[illegible]		
[illegible]	11 35	0000	[illegible]	[illegible]	
	11 35	0020	[illegible]		
	11 35	0040	[illegible]		
	11 35	0045	[illegible]		
[illegible]	04 25	0000	[illegible]	[illegible]	
	04 25	0005	[illegible]		
	04 25	0010	[illegible]		
	04 25	0025	[illegible]		
	04 25	0040	[illegible]		
	04 25	0053	[illegible]		

[illegible] WATERSHED PROJECT [illegible]

[illegible]
[illegible] OF [illegible] AND [illegible]
[illegible] LITTLE ELM [illegible]
[illegible] T.[illegible]

[illegible] 3 [illegible] FEET [illegible]

DATE FROM TO	TIME OF DAY	DEPTH FEET	[illegible] (MG/L) CENT	[illegible] (%) [illegible] (MG/L)	[illegible] THAMSP SECCHI INCHES	[illegible] CHOLIFORM FIELD [illegible]	[illegible] (MG/L)	[illegible] T ALK CACO3 (MG/L)	[illegible] (MG/L)	[illegible] TOT K JEL (MG/L)	[illegible] N (MG/L)	[illegible] (MG/L)
[illegible]	12 10	[illegible]	[illegible]		24	385	8.28	128	0.264	0.388	0.258	0.487
	12 10	[illegible]	[illegible]	8.5		297	8.28	114	0.268	0.299	0.268	0.389
	12 10	[illegible]	[illegible]	8.2		288	8.15	109	0.264	0.288	0.268	0.417
	12 10	[illegible]	[illegible]	8.8		291	8.68	108	0.249	0.288	0.338	0.519
[illegible]	10 08	[illegible]	[illegible]		28	384	8.28	134	0.378	0.336	0.358	0.508
	10 08	[illegible]	[illegible]	8.8		384	8.38	134	0.358	0.588	0.388	0.487
	10 08	[illegible]	[illegible]	8.8		384	8.25	134	0.378	0.488	0.328	0.487
	10 08	[illegible]	[illegible]	7.2		383	7.65	117	0.246	0.488	0.446	0.852
[illegible]	12 05	[illegible]	[illegible]	7.8	41	385	8.54	128	0.268	0.488	0.8278	0.884
	12 05	[illegible]	[illegible]	8.8		354	8.48	134	0.358	0.388	0.8284	0.384
	12 05	[illegible]	[illegible]	7.2		354	8.13	121	0.268	0.388	0.828	0.811
[illegible]	10 28	[illegible]	[illegible]	7.2	3	195	7.87	85	0.248	1.188	0.388	0.854
	10 28	[illegible]	[illegible]	7.2		187	7.87	83	0.248	1.388	0.438	0.854
	10 28	[illegible]	[illegible]	7.2		187	7.87	74	0.178	2.288	0.448	0.861
	10 28	[illegible]	[illegible]	8.4		179	7.93	98	0.388	2.488	0.428	0.871

DATE FROM TO	TIME OF DAY	DEPTH FEET	[illegible] (MG/L) *	[illegible] CHLOROPHYL A (MG/L)	[illegible] INCOT LT REMAINS PERCENT
[illegible]	12 10	[illegible]	0.827	1.8	
	12 10	[illegible]	0.838		
	12 10	[illegible]	0.831		
	12 10	[illegible]	0.841		
[illegible]	10 08	[illegible]	0.842	31.7	
	10 08	[illegible]	0.841		
	10 08	[illegible]	0.841		
	10 08	[illegible]	0.847		
[illegible]	12 05	[illegible]	0.832	12.8	
	12 05	[illegible]	0.833		
	12 05	[illegible]	0.841		
[illegible]	10 28	[illegible]	0.361	4.1	
	10 28	[illegible]	0.762		
	10 28	[illegible]	0.854		
	10 28	[illegible]	0.298		

* VALUE [illegible] TO BE LESS THAN INDICATED

[illegible]

[illegible]

[illegible]
33 04 52.0 097 37 08.0
[illegible] LITTLE ELM RESERVOIR
[illegible] T.Wb

[illegible]
3

[illegible]
0838 FEET [illegible]

DATE	TIME	DEPTH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FROM	OF		TEMP		SECCHI	FIELD						
TO	DAY	FEET	DEG C	MG/L	[illegible]	[illegible]	SU	MG/L	MG/L	MG/L	MG/L	MG/L P
04/05/28	11	15 [illegible]	26.7			12	433	6.10	39	0.850	0.460	0.746	0.881
	11	15 [illegible]	26.6	6.6			435	6.10	116	0.846	0.468	0.738	0.878
04/08/12	15	38 [illegible]	27.2	7.4		13	373	8.63	121	0.868	0.488	0.868	0.827
	15	39 [illegible]	26.3	7.2			367	8.64	120	0.866	0.388	0.868	0.821
04/10/31	11	38 [illegible]	14.5	7.4		3	194	7.75	92	0.128	0.488	0.268	0.876
	11	38 [illegible]	14.7	7.6			194	7.68	75	0.140	0.488	0.278	0.873

DATE	TIME	DEPTH	[illegible]	[illegible]	[illegible]
FROM	OF		A	[illegible]	
TO	DAY	FEET	MG/L P	[illegible]	[illegible]
04/05/28	11	15 [illegible]	0.210	14.3	
	11	15 [illegible]			1.0
	11	15 [illegible]	0.204		
04/08/12	15	37 [illegible]	0.347	25.0	
	15	38 [illegible]	0.342		
04/10/31	11	38 [illegible]	0.378	23.7	
	11	38 [illegible]	0.458		

APPENDIX I

TRIBUTARY AND WASTEWATER TREATMENT PLANT DATA

[illegible]

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DATE	TIME	DEPTH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TO	[illegible]	FEET	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	11	50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	10	30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	09	10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	09	30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	09	00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	09	30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	07	30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	08	45	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	08	30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	08	00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	07	30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	09	15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	09	45	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	18	20	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	18	30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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